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GENERAL SEMANTICS

I. INTRODUCTION

On the hypothesis that all natural or artificial languages of interest to us can be given transformational grammars of a certain not-very-special sort, it becomes possible to give very simple general answers to the questions:

(1) What sort of thing is a meaning?
(2) What is the form of the semantic rules whereby meanings of compounds are built up from the meanings of their constituent parts?

It is not my plan to make any strong empirical claim about language. To the contrary: I want to propose a convenient format for semantics general enough to work for a great variety of logically possible languages. This paper therefore belongs not to empirical linguistic theory but to the philosophy thereof.

My proposals regarding the nature of meanings will not conform to the expectations of those linguists who conceive of semantic interpretation as the assignment to sentences and their constituents of compounds of 'semantic markers' or the like. (Katz and Postal, 1964, for instance.) Semantic markers are *symbols*: items in the vocabulary of an artificial language we may call *Semantic Markerese*. Semantic interpretation by means of them amounts merely to a translation algorithm from the object language to the auxiliary language Markerese. But we can know the Markerese translation of an English sentence without knowing the first thing about the meaning of the English sentence: namely, the conditions under which it would be true. Semantics with no treatment of truth conditions is not semantics. Translation into Markerese is at best a substitute for real semantics, relying either on our tacit competence (at some future date) as speakers of Markerese or on our ability to do real semantics at least for the one language Markerese. Translation into Latin might

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serve as well, except insofar as the designers of Markerese may choose to build into it useful features – freedom from ambiguity, grammar based on symbolic logic – that might make it easier to do real semantics for Markerese than for Latin. (See Vermazen, 1967, for similar criticisms).

The Markerese method is attractive in part just because it deals with nothing but symbols: finite combinations of entities of a familiar sort out of a finite set of elements by finitely many applications of finitely many rules. There is no risk of alarming the ontologically parsimonious. But it is just this pleasing finitude that prevents Markerese semantics from dealing with the relations between symbols and the world of non-symbols – that is, with genuinely semantic relations. Accordingly, we should be prepared to find that in a more adequate method, meanings may turn out to be complicated, infinite entities built up out of elements belonging to various ontological categories.

My proposals will also not conform to the expectations of those who, in analyzing meaning, turn immediately to the psychology and sociology of language users: to intentions, sense-experience, and mental ideas, or to social rules, conventions, and regularities. I distinguish two topics: first, the description of possible languages or grammars as abstract semantic systems whereby symbols are associated with aspects of the world; and second, the description of the psychological and sociological facts whereby a particular one of these abstract semantic systems is the one used by a person or population. Only confusion comes of mixing these two topics. This paper deals almost entirely with the first. (I discuss the second elsewhere: Lewis, 1968b and 1969, Chapter V.)

My proposals are in the tradition of *referential*, or *model-theoretic*, semantics descended from Frege, Tarski, Carnap (in his later works), and recent work of Kripke and others on semantic foundations of intensional logic. (See Frege, 1892; Tarski, 1936; Carnap, 1947 and 1963, § 9; Kripke, 1963; Kaplan, 1964; Montague, 1960, 1968, and 1971; Scott, 1970.) The project of transplanting referential semantics from artificial to natural languages has recently been undertaken, in various ways, by several philosophers and linguists (Davidson, 1967; Parsons, 1968; Montague, 1969, 1970a, and 1970b; Keenan, 1969.) I have no quarrel with these efforts; indeed, I have here adapted features from several of them. I hope, however, that the system set forth in this paper offers a simpler way to do essentially the same thing. But simplicity is a matter of taste, and

simplicity at one place trades off against simplicity elsewhere. It is in these trade-offs that my approach differs most from the others.

II. CATEGORIALLY BASED GRAMMARS

A *categorial grammar* in the sense of Ajdukiewicz (Ajdukiewicz, 1935; Bar-Hillel, 1964, Part II) is a context-free phrase structure grammar of the following sort.

First, we have a small number of *basic categories*. One of these is the category *sentence* (S). Others might be, for instance, the categories *name* (N) and *common noun* (C). Perhaps we can get by with these three and no more; indeed, Ajdukiewicz went so far as to do without the category *common noun*. Or perhaps we might do better to use different basic categories; we will consider dispensing with the category *name* in favor of an alternative basic category *verb phrase* (VP), or perhaps *noun phrase* (NP).

Second, we have infinitely many *derived categories*. Whenever c, c_1, ..., c_n ($n \geqslant 1$) are any categories, either basic or derived, we have a derived category which we will write $(c/c_1 \ldots c_n)$. (However, we will usually omit the outermost parentheses.)

Third, we have context-free phrase-structure rules of the form

$$c \rightarrow (c/c_1 \ldots c_n) + c_1 + \cdots + c_n$$

corresponding to each derived category. That is to say: for any categories c, c_1, ..., c_n, the result of concatenating any expression of category $(c/c_1 \ldots c_n)$, then any expression of category c_1, then..., and finally any expression of category c_n is an expression of category c. Accordingly, we will say that a $(c/c_1 \ldots c_n)$ *takes* a c_1 and ... and a c_n and *makes* a c. The phrase-structure rules are implicit in the system of derived categories.

Finally, we have a lexicon wherein finitely many expressions – words or word-like morphemes – are assigned to categories. The categories of these lexical expressions may be either basic or derived; unless some lexical expressions belong to derived categories, no non-lexical compound expressions can be generated. Notice that although there are infinitely many derived categories and infinitely many phrase-structure rules, nevertheless with any given lexicon all but finitely many categories and

rules will be unemployed. This is true even though many lexica will generate infinitely many compound expressions.

To specify a categorial grammar, we need only specify its lexicon. The rest is common to all categorial grammars. Consider this lexicon:

$$\left\{\begin{array}{llll} \langle \text{a} & (S/(S/N))/C\rangle & \langle \text{pig} & C\rangle \\ \langle \text{believes} & (S/N)/S\rangle & \langle \text{piggishly} & (S/N)/(S/N)\rangle \\ \langle \text{every} & (S/(S/N))/C\rangle & \langle \text{Porky} & N\rangle \\ \langle \text{grunts} & S/N\rangle & \langle \text{something} & S/(S/N)\rangle \\ \langle \text{is} & (S/N)/N\rangle & \langle \text{the} & (S/(S/N))/C\rangle \\ \langle \text{loves} & (S/N)/N\rangle & \langle \text{which} & (C/C)/(S/N)\rangle \\ \langle \text{Petunia} & N\rangle & \langle \text{yellow} & C/C\rangle \end{array}\right\}$$

It gives us a categorial grammar which is simply a notational variant of this rather commonplace context-free grammar:

$$\begin{array}{rl} S \rightarrow & \left\{\begin{array}{l} NP+VP \\ VP+Npr \end{array}\right. \\ VP \rightarrow & \left\{\begin{array}{l} Adv+VP \\ Vt+Npr \\ Vs+S \end{array}\right. \\ NP \rightarrow & Art+Nco \\ Nco \rightarrow & Adj+Nco \\ Adj \rightarrow & Rel+VP \end{array} \qquad \begin{array}{rl} Npr \rightarrow & \left\{\begin{array}{l} \text{Porky} \\ \text{Petunia} \end{array}\right. \\ NP \rightarrow & \text{something} \\ Nco \rightarrow & \text{pig} \\ VP \rightarrow & \text{grunts} \\ Vt \rightarrow & \left\{\begin{array}{l} \text{loves} \\ \text{is} \end{array}\right. \\ Vs \rightarrow & \text{believes} \\ Art \rightarrow & \left\{\begin{array}{l} \text{a} \\ \text{every} \\ \text{the} \end{array}\right. \\ Adj \rightarrow & \text{yellow} \\ Adv \rightarrow & \text{piggishly} \\ Rel \rightarrow & \text{which} \end{array}$$

There are three peculiarities about the grammar. First, proper nouns are distinguished from noun phrases. Proper nouns or noun phrases may be subjects (though with different word order) but only proper nouns may be objects. Second, there is nothing to prevent inappropriate iteration of modifiers. Third, the word order is sometimes odd. We will see later how these peculiarities may be overcome.

The employed rules in this example are the eight phrase-structure rules corresponding to the eight employed derived categories.

In this example, I have used only derived categories of the form (c/c_1) that take a single argument. I shall adopt this restriction for the most part in practice, but not in principle.

It is apparent that categorial grammars of this sort are not reasonable grammars for natural language. For that matter, they are not reasonable grammars for most artificial languages either – the exception being symbolic logic in Polish notation. Hence, despite their elegance, categorial grammars have largely been ignored since the early 1950's. Since then, however, we have become interested in the plan of using a simple phrase-structure grammar as a base for a transformational grammar. The time therefore seems ripe to explore *categorially based transformational grammars*, obtained by taking an Ajdukiewicz categorial grammar as base and adding a transformational component. So far as I know, this proposal has been made only once before (Lyons, 1966), but it seems an obvious one.

It is obvious that by adding a transformational component to the categorial grammar of our example, we could rectify the word order and filter out inappropriate iterations of modifiers. Less obviously, we could provide for noun phrase objects by means of a transformational component together with a few additional lexical items – items that need never appear in the final generated sentences.

If reasonable categorially based transformational grammars can be given for all languages of interest to us, and if this can be done under the constraint that meanings are to be determined entirely by base structure, so that the transformational component is irrelevant to semantics, then it becomes extremely easy to give general answer to the questions: What is a meaning? What is the form of a semantic projection rule? Let us see how this can be done.

III. INTENSIONS FOR BASIC CATEGORIES

In order to say what a meaning *is*, we may first ask what a meaning *does*, and then find something that does that.

A meaning for a sentence is something that determines the conditions under which the sentence is true or false. It determines the truth-value of the sentence in various possible states of affairs, at various times, at various places, for various speakers, and so on. (I mean this to apply even

to non-declarative sentences, but postpone consideration of them.) Similarly, a meaning for a name is something that determines what thing, if any, the name names in various possible states of affairs, at various times, and so on. Among 'things' we include things that do not actually exist, but *might* exist in states of affairs different from the actual state of affairs. Similarly, a meaning for a common noun is something that determines which (possible or actual) things, if any, that common noun applies to in various possible states of affairs, at various times, and so on.

We call the truth-value of a sentence the *extension* of that sentence; we call the thing named by a name the *extension* of that name; we call the set of things to which a common noun applies the *extension* of that common noun. The extension of something in one of these three categories depends on its meaning and, in general, on other things as well: on facts about the world, on the time of utterance, on the place of utterance, on the speaker, on the surrounding discourse, etc. It is the meaning which determines how the extension depends upon the combination of other relevant factors. What sort of things determine how something depends on something else? *Functions*, of course; functions in the most general set-theoretic sense, in which the domain of arguments and the range of values may consist of entities of any sort whatever, and in which it is not required that the function be specifiable by any simple rule. We have now found something to do at least part of what a meaning for a sentence, name, or common noun does: a function which yields as output an appropriate extension when given as input a package of the various factors on which the extension may depend. We will call such an input package of relevant factors an *index*; and we will call any function from indices to appropriate extensions for a sentence, name, or common noun an *intension*.

Thus an *appropriate intension for* a sentence is any function from indices to truth-values; an *appropriate intension for* a name is any function from indices to things; an *appropriate intension for* a common noun is any function from indices to sets. The plan to construe intensions as extension-determining functions originated with Carnap. (Carnap, 1947, § 40, and 1963.) Accordingly, let us call such functions *Carnapian intensions*. But whereas Carnap's extension-determining functions take as their arguments models or state-descriptions representing possible worlds, I will adopt the

suggestion (Montague, 1968; Scott, 1970) of letting the arguments be packages of miscellaneous factors relevant to determining extensions.

We may take indices as n-tuples (finite sequences) of the various items other than meaning that may enter into determining extensions. We call these various items *coordinates* of the index, and we shall assume that the coordinates are given some arbitrary fixed order.

First, we must have a *possible-world coordinate.* Contingent sentences depend for their truth value on facts about the world, and so are true at some possible worlds and false at others. A possible world corresponds to a possible totality of facts, determinate in all respects. Common nouns also have different extensions at different possible worlds; and so do some names, at least if we adopt the position (defended in Lewis, 1968a) that things are related to their counterparts in other worlds by ties of strong similarity rather than identity.

Second, we must have several *contextual coordinates* corresponding to familiar sorts of dependence on features of context. (The world coordinate itself might be regarded as a feature of context, since different possible utterances of a sentence are located in different possible worlds.) We must have a *time coordinate,* in view of tensed sentences and such sentences as 'Today is Tuesday'; a *place coordinate,* in view of such sentences as 'Here there are tigers'; a *speaker coordinate* in view of such sentences as 'I am Porky'; an *audience coordinate* in view of such sentences as 'You are Porky'; an *indicated-objects coordinate* in view of such sentences as 'That pig is Porky' or 'Those men are Communists'; and a *previous discourse coordinate* in view of such sentences as 'The aforementioned pig is Porky'.

Third, it is convenient to have an *assignment coordinate*: an infinite sequence of things, regarded as giving the values of any variables that may occur free in such expressions as 'x is tall' or 'son of y'. Each variable employed in the language will accordingly be a name having as its intension, for some number n, the *nth variable intension*: that function whose value, at any index i, is that thing which is the nth term of the assignment coordinate of i. That thing is the extension, or value, of the variable at i. (Note that because there is more than one possible thing, the variable intensions are distinct: nothing is both the n_1th and the n_2th variable intension for two different numbers n_1 and n_2.) The extensions of 'x is tall' of 'son of y' depend on the assignment and world coordinates of indices

just as the extensions of 'I am tall' of 'son of mine' depend on the speaker and world coordinates. Yet the assignment coordinate cannot naturally be included among features of context. One might claim that variables do not appear in sentences of natural languages; but even if this is so, it may be useful to employ variables in a categorial base. In any case, I seek sufficient generality to accommodate languages that do employ variables.

Perhaps other coordinates would be useful. (See the Appendix.) But let us stop here, even though the penalty for introducing a superfluous coordinate is mere clutter, while the penalty for omitting a needed one is inadequacy. Thus an *index* is tentatively any octuple of which the first coordinate is a possible world, the second coordinate is a moment of time, the third coordinate is a place, the fourth coordinate is a person (or other creature capable of being a speaker), the fifth coordinate is a set of persons (or other creatures capable of being an audience), the sixth coordinate is a set (possibly empty) of concrete things capable of being pointed at, the seventh coordinate is a segment of discourse, and the eight coordinate is an infinite sequence of things.

Intensions, our functions from indices to extensions, are designed to do part of what meanings do. Yet they are not meanings; for there are differences in meaning unaccompanied by differences in intension. It would be absurd to say that all tautologies have the same meaning, but they have the same intension; the constant function having at every index the value *truth*. Intensions are part of the way to meanings, however, and they are of interest in their own right. We shall consider later what must be added to an intension to obtain something that can do *all* of what a meaning does.

We may permit Carnapian intensions to be partial functions from indices, undefined at some indices. A name may not denote anything at a given possible world. 'Pegasus', for instance, denotes nothing at our world, so its intension may be taken as undefined at any index having our world as its world coordinate. A sentence that suffers from failure of presupposition is often thought to lack a truth-value (for instance in Strawson, 1950; Keenan, 1969; McCawley, 1969). If we adopt this treatment of presupposition, sentences susceptible to lack of truth-value should have intensions that are undefined at some indices. They might even have intensions that are undefined at *all* indices; a sentence with

inconsistent presuppositions should have as its intension the empty function, defined at no index.

Hitherto I have spoken uncritically of 'things'. Things are name extensions and values of name intensions; sets of things are common-noun extensions and values of common-noun intensions; sequences of things are assignment coordinates of indices. Change the underlying set of things and we change the sets of extensions, indices, and Carnapian intensions. What, then, are things? Of course I want to say, once and for all: *everything* is a thing. But I must not say that. Not all sets of things can be things; else the set of things would be larger than itself. No Carnapian intension can be a thing (unless it is undefined at certain indices); else it would be a member of ... a member of itself. We must understand the above definitions of extensions, indices, and Carnapian intensions (and the coming definitions of compositional intensions, meanings, and lexica) as tacitly relativized to a chosen set of things. Can we choose the set of things once and for all? Not quite; no matter what set we choose as the set of things, the system of intensions defined over that set will not provide intensions for certain terms – 'intension', for instance – of the semantic metalanguage corresponding to that choice. Consider the language of this paper (minus this paragraph) with the extension of 'thing' somehow fixed; it is an adequate semantic metalanguage for some languages but not for itself. To do semantics for it, we must move to a second language in which 'thing' is taken more inclusively; to do semantics for that language we must move to a third language in which 'thing' is taken more inclusively still; and so on. Any language can be treated in a metalanguage in which 'thing' is taken inclusively enough; but the generality of semantics is fundamentally limited by the fact that no language can be its own semantic metalanguage (Cf. Tarski, 1936) and hence there can be no universal semantic metalanguage. But we can approach generality as closely as we like by taking 'thing' inclusively enough. For the remainder of this paper, let us proceed on the assumption that the set of things has been chosen, almost once and for all, as some very inclusive set: at least as the universe of some intended model of standard set theory with all the non-sets we want, actual or possible, included as individuals. Let us ignore the sequence of semantic metalanguages that still escape treatment.

In that case there is overlap between things, sets of things, and truth-

values. (Not all sets of things can be things, but some should be.) Moreover, there is overlap between sets and truth-values if we adopt the common conventions of identifying the truth-values *truth* and *falsity* with the numbers 1 and 0 respectively, and of identifying each natural number with the set of its predecessors. Thus the appropriate extensions and intensions for sentences, names, and common nouns overlap. The same function that is the intension of all contradictions is also the intension of the name 'zero' and of the common noun 'round square'. Such overlap, however, is harmless. Whenever we want to get rid of it, we can replace intensions by ordered pairs of a category and an intension appropriate for that category.

IV. INTENSIONS FOR DERIVED CATEGORIES

Turning to derived categories, it is best to foresake extensions and Carnapian intensions in the interest of generality. Sometimes, for instance, a C/C – that is, an *adjective* – has an extension like that of a common noun: a set of things to which (at a given index) it applies. Probably 'married' is such an *extensional adjective*. But most adjectives do not have extensions. What is the set of things to which 'alleged' applies? An alleged Communist is not something which is, on the one hand, an alleged thing and, on the other hand, a Communist.

In general, an adjective takes a common noun to make a new, compound common noun; and the intension of the new common noun depends on the intension of the original common noun in a manner determined by the meaning of the adjective. A meaning for an adjective, therefore, is something that determines how one common-noun intension depends on another. Looking for an entity that does what a meaning does, we are led to say that an appropriate intension for an adjective is any function from common-noun intensions to common-noun intensions. In more detail: it is a function whose domain and range consist of functions from indices to sets. Thus the intension of 'alleged' is a function that, when given as argument the intension of 'Communist', 'windshield', or, 'chipmunk' yields as value the intension of the compound common noun 'alleged Communist', 'alleged windshield', or 'alleged chipmunk' respectively. Note that it would not work to use instead a function from common-noun extensions (sets) to common-noun extensions; for at certain

indices 'Communist' and 'Maoist' have the same extension but 'alleged Communist' and 'alleged Maoist' do not – or, at other indices, vice versa.

More generally, let us say that an *appropriate intension for* a $(c/c_1 \ldots c_n)$, where c, c_1, ..., and c_n are any categories, basic or derived, is any n-place function from c_1-intensions, ..., and c_n-intensions to c-intensions. That is, it is any function (again in the most general set-theoretic sense) having as its range of values a set of c-intensions, having as its domain of first arguments the set of c_1-intensions, ..., and having as its domain of nth arguments the set of c_n-intensions. A $(c/c_1 \ldots c_n)$ takes a c_1 and ... and a c_n and makes a c by concatenation; correspondingly, a $(c/c_1 \ldots c_n)$-intension takes a c_1-intension and ... and a c_n-intension as arguments and makes a c-intension as function value. We will call these intensions for derived categories *compositional intensions*. (Intensions resembling some of my compositional intensions are discussed in Kaplan, 1964; in Scott, 1970; and – as appropriate intensions for adjectives and other modifiers – in Parsons, 1968 and Montague, 1970a. The latter discussion is due in part to J. A. W. Kamp.) The general form of the semantic projection rules for an interpreted categorial grammar is implicit in the nature of compositional intensions, just as the general form of the phrase-structure rules is implicit in the nomenclature for derived categories. The result of concatenating a $(c/c_1 \ldots c_n)$ with intension ϕ_0, a c_1 with intension ϕ_1, ..., and a c_n with intension ϕ_n is a c with intension $\phi_0(\phi_1 \ldots \phi_n)$.

We have considered already the derived category *adjective* C/C. For another example, take the derived category *verb phrase*, S/N.

A verb phrase takes a name to make a sentence. (We rely on the transformational component to change the word order if necessary.) An appropriate intension for a verb phrase – an S/N-intension – is therefore a function from name intensions to sentence intensions. That is, it is a function from functions from indices to things to functions from indices to truth values. The intension of 'grunts', for instance, is that function ϕ whose value, given as argument any function ϕ_1 from indices to things, is that function ϕ_2 from indices to truth values such that, for any index i,

$$\phi_2(i) = \begin{cases} \textit{truth} \text{ if } \phi_1(i) \text{ is something which grunts at the world and time given by the appropriate coordinates of } i \\ \textit{falsity} \text{ otherwise.} \end{cases}$$

Applying the projection rule, we find that the sentence 'Porky grunts' is true at just those indices i such that the thing named by 'Porky' at i grunts at the possible world that is the world coordinate of i at the time which is the time coordinate of i. (The appearance of circularity in this account is spurious; it comes of the fact that I am using English to specify the intension of a word of English.)

For another example, take the derived category *adverb* (of one sort), (S/N) (S/N). An adverb of this sort takes a verb phrase to make a verb phrase; so an appropriate intension for such an adverb – an (S/N)/(S/N)-intension – is a function from verb-phrase intensions to verb-phrase intensions; or, in more detail, a function from functions from functions from indices to things to functions from indices to truth-values to functions from functions from indices to things to functions from indices to truth-values.

I promised simplicity; I deliver functions from functions from functions to functions to functions from functions to functions. And worse is in store if we consider the sort of adverb that modifies ordinary adverbs: the category ((S/N)/(S/N))/((S/N)/(S/N)). Yet I think no apology is called for. Intensions are complicated constructs, but the principles of their construction are extremely simple. The situation is common: look at any account of the set-theoretic construction of real numbers, yet recall that children often understand the real numbers rather well.

In some cases, it would be possible to find simpler intensions, but at an exorbitant cost: we would have to give up the uniform function-and-arguments form for semantic projection rules. We have noted already that some adjectives are extensional, though most are not. The extensional adjectives could be given sets as extensions and functions from indices to sets as Carnapian intensions. Similarly for verb phrases: we may call a verb phrase *extensional* iff there is a function ϕ from indices to sets such that if ϕ_1 is the (compositional) intension of the verb phrase, ϕ_2 is any name intension, ϕ_3 is $\phi_1(\phi_2)$, and i is any index, then

$$\phi_3(i) = \begin{cases} \textit{truth} \text{ if } \phi_2(i) \text{ is a member of } \phi(i) \\ \textit{falsity} \text{ otherwise.} \end{cases}$$

If there is any such function ϕ, there is exactly one; we can call it the Carnapian intension of the verb phrase and we can call its value at any index i the extension of the verb phrase at i. 'Grunts', for instance, is an

extensional verb phrase; its extension at an index *i* is the set of things that grunt at the world and the time given by the world coordinate and the time coordinate of the index *i*. Verb phrases, unlike adjectives, are ordinarily extensional; but Barbara Partee has pointed out that the verb phrase in 'The price of milk is rising' seems to be non-extensional.

There is no harm in noting that extensional adjectives and verb phrases have Carnapian intensions as well as compositional intensions. However, it is the compositional intension that should be used to determine the intension of an extensional-adjective-plus-common-noun or extensional-verb-phrase-plus-name combination. If we used the Carnapian intensions, we would have a miscellany of semantic projection rules rather than the uniform function-and-arguments rule. (Indeed, the best way to formulate projection rules using Carnapian intensions might be to combine a rule for reconstructing compositional intensions from Carnapian intensions with the function-and-arguments rule for compositional intensions.) Moreover, we would sacrifice generality: non-extensional adjectives and verb phrases would have to be treated separately from the extensional ones, or not at all. This loss of generality would be serious in the case of adjectives; but not in the case of verb phrases since there are few, if any, non-extensional verb phrases.

For the sake of generality, we might wish to take account of selection restrictions by allowing a compositional intension to be undefined for some arguments of appropriate type. If we thought that 'green idea' should lack an intension, for instance, we might conclude that the intension of 'green' ought to be a partial function from common-noun intensions to common-noun intensions, undefined for such arguments as the intension of 'idea'. It proves more convenient, however, never to let the intension be undefined but rather to let it take on a value called the *null intension* (for the appropriate category). The null intension for the basic categories will be the empty function; the null intension for any derived category $(c/c_1 \ldots c_n)$ will be that $(c/c_1 \ldots c_n)$-intension whose value for any combination of appropriate arguments is the null intension for c. Thus the intension of 'green', given as argument the intension of 'idea', yields as value the null intension for the category C. The intension of the adverb 'furiously', given as argument the intension of 'sleeps', yields as value the null intension for the category (S/N, and that in turn, given as value any name intension, yields as value the null intension for the category S. (I dislike

this treatment of selection restrictions, but provide the option for those who want it.)

It is worth mentioning that my account of intensions for derived categories, and of the corresponding form for projection rules, is independent of my account of intensions for basic categories. Whatever S-intensions and N-intensions may be – even expressions of Markerese or ideas in someone's mind – it still is possible to take S/N-intensions as functions from N-intensions to S-intensions and to obtain the intension of 'Porky grunts' by applying the intension of 'grunts' as function to the intension of 'Porky' as argument.

V. MEANINGS

We have already observed that intensions for sentences cannot be identified with meanings since differences in meaning – for instance, between tautologies – may not carry with them any difference in intension. The same goes for other categories, basic or derived. Differences in intension, we may say, give us *coarse* differences in meaning. For *fine* differences in meaning we must look to the analysis of a compound into constituents and to the intensions of the several constituents. For instance 'Snow is white or it isn't' differs finely in meaning from 'Grass is green or it isn't' because of the difference in intension between the embedded sentences 'Snow is white' and 'Grass is green'. For still finer differences in meaning we must look in turn to the intensions of constituents of constituents, and so on. Only when we come to non-compound, lexical constituents can we take sameness of intension as a sufficient condition of synonymy. (See Carnap, 1947, § 14, on 'intensional isomorphism'; C. I. Lewis, 1944, on 'analytic meaning'.)

It is natural, therefore, to identify meanings with semantically interpreted phrase markers minus their terminal nodes: finite ordered trees having at each note a category and an appropriate intension. If we associate a meaning of this sort with an expression, we are given the category and intension of the expression; and if the expression is compound, we are given also the categories and intensions of its constituent parts, their constituent parts, and so on down.

Perhaps we would thereby cut meanings too finely. For instance, we will be unable to agree with someone who says that a double negation

has the same meaning as the corresponding affirmative. But this difficulty does not worry me: we will have both intensions and what I call meanings, and sometimes one and sometimes the other will be preferable as an explication of our ordinary discourse about meanings. Perhaps some entities of intermediate fineness can also be found, but I doubt that there is any uniquely natural way to do so.

It may be disturbing that in our explication of meanings we have made arbitrary choices – for instance, of the order of coordinates in an index. Meanings are meanings – how can we *choose* to construct them in one way rather than another? The objection is a general objection to set-theoretic constructions (see Benacerraf, 1965), so I will not reply to it here. But if it troubles you, you may prefer to say that *real* meanings are *sui generis* entities and that the constructs I call 'meanings' do duty for real meanings because there is a natural one-to-one correspondence between them and the real meanings.

It might also be disturbing that I have spoken of categories without hitherto saying what they are. This again is a matter of arbitrary choice; we might, for instance, take them as sets of expressions in some language, or as sets of intensions, or even as arbitrarily chosen code-numbers. It turns out to be most convenient, if slightly unnatural, to identify categories with their own names: expressions composed in the proper way out of the letters 'S', 'N', 'C' (and whatever others we may introduce later in considering revisions of the system) together with parentheses and diagonal slashes. This does not prevent our category-names from being names of categories: they name themselves. All definitions involving categories are to be understood in accordance with the identification of categories and category-names.

Some might even wish to know what a *tree* is. Very well: it is a function that assigns to each member of the set of nodes of the tree an object said to *occupy* or be *at* that node. The nodes themselves are finite sequences of positive numbers. A set of such sequences is the set of *nodes of* some tree iff, first, it is a finite set, and second, whenever it contains a sequence $\langle b_1 \ldots b_k \rangle$ then it also contains every sequence that is an initial segment of $\langle b_1 \ldots b_k \rangle$ and every sequence $\langle b_1 \ldots b_{k-1} b_k' \rangle$ with $b_k' < b_k$. We regard $\langle\ \rangle$, the sequence of zero length, as the topmost node; $\langle b_1 \rangle$ as the b_1th node from the left immediately beneath $\langle\ \rangle$; $\langle b_1\ b_2 \rangle$ as the b_2th node from the left immediately beneath $\langle b_1 \rangle$; and so on. We can easily define

all the requisite notions of tree theory in terms of this construction.

Once we have identified meanings with semantically interpreted phrase markers, it becomes natural to reconstrue the phrase-structure rules of categorial grammar, together with the corresponding projection rules, as conditions of well-formedness for meanings. (Cf. McCawley, 1968.) Accordingly, we now define a *meaning* as a tree such that, first, each node is occupied by an ordered pair $\langle c\ \phi \rangle$ of a category and an appropriate intension for that category; and second, immediately beneath any nonterminal node occupied by such a pair $\langle c\ \phi \rangle$ are two or more nodes, and these are occupied by pairs $\langle c_0\ \phi_0 \rangle$, $\langle c_1\ \phi_1 \rangle$, ..., $\langle c_n\ \phi_n \rangle$ (in that order) such that c_0 is $(c/c_1 \ldots c_n)$ and ϕ is $\phi_0(\phi_1 \ldots \phi_n)$.

A meaning may be a tree with a single node; call such meanings *simple* and other meanings *compound.* Compound meanings are, as it were, built up from simple meanings by steps in which several meanings (simple or compound) are combined as sub-trees under a new node, analogously to the way in which expressions are built up by concatenating shorter expressions. We may call a meaning m' a *constituent of* a meaning m iff m' is a subtree of m. We may say that a meaning m is *generated by* a set of simple meanings iff every simple constituent of m belongs to that set. More generally, m is *generated by* a set of meanings (simple or compound) iff every simple constituent of m is a constituent of some constituent of m, possibly itself, which belongs to that set.

We shall in many ways speak of meanings as though they were symbolic expressions generated by an interpreted categorial grammar, even though they are nothing of the sort. The *category of* a meaning is the category found as the first component of its topmost node. The *intension of* a meaning is the intension found as the second component of its topmost node. The *extension at* an index *i of* a sentence meaning, name meaning, or common-noun meaning is the value of the intension of the meaning for the argument *i.* A sentence meaning is *true* or *false at i* according as its extension at *i* is *truth* or *falsity*; a name meaning *names at i* that thing, if any, which is its extension at *i*; and a common-noun meaning *applies at i* to whatever things belong to its extension at *i.* As we have seen, extensions might also be provided for certain meanings in derived categories such as C/C or S/N, but this cannot be done in a non-artificial, general way.

Given as fundamental the definition of truth of a sentence meaning at

an index, we can define many derivative truth relations. Coordinates of the index may be made explicit, or may be determined by a context of utterance, or may be generalized over. Generalizing over all coordinates, we can say that a sentence meaning is *analytic* (in one sense) iff it is true at every index. Generalizing over the world and assignment coordinates and letting the remaining coordinates be determined by context, we can say that a sentence meaning is *analytic* (in another sense) *on* a given occasion iff it is true at every index i having as its time, place, speaker, audience, indicated-objects and previous-discourse coordinates respectively the time, the place, the speaker, the audience, the set of objects pointed to, and the previous discourse on that occasion. Generalizing over the time and assignment coordinates and letting the others (including world) be determined by context, we define *eternal truth* of a sentence meaning *on* an occasion; generalizing over the assignment coordinate and letting all the rest be determined by context, we define simply *truth on* an occasion; and so on.

We also can define truth relations even stronger than truth at every index. Let us call a meaning m' a *semantic variant* of a meaning m iff m and m' have exactly the same nodes, with the same category but not necessarily the same intension at each node, and, whenever a common intension appears at two terminal nodes in m, a common intension also appears at those two nodes in m'. Let us call m' an *s-fixed semantic variant of* m, where s is a set of simple meanings, iff m and m' are semantic variants and every member of s which is a constituent of m is also a constituent, at the same place, of m'. Then we can call a sentence meaning *s-true* iff every s-fixed semantic variant of it (including itself) is true at every index. If s is the set of simple meanings whose bearers we would classify as logical vocabulary, then we may call s-true sentence meanings *logically true*; if s is the set of simple meanings whose bearers we would classify as mathematical (including logical) vocabulary, we may call s-true sentence meanings *mathematically true*. Analogously, we can define a relation of s-fixed semantic variance between sequences of meanings; and we can say that a sentence meaning m_0 is an *s-consequence* (for instance, a *logical consequence* or *mathematical consequence*) of sentence meanings $m_1, \ldots$ iff, for every s-fixed semantic variant $\langle m_0' m_1' \ldots \rangle$ of the sequence $\langle m_0 m_1 \ldots \rangle$ and every index i such that all of $m_1', \ldots$ are true at i, m_0' is true at i. (The premises $m_1, \ldots$ may be infinite in number. Their order is

insignificant.) These definitions are adapted from definitions in terms of truth in all logically or mathematically standard interpretations of a given language. However, we have been able to avoid introducing the notion of alternative interpretations of a language, since so far we are dealing entirely with meanings.

VI. GRAMMARS RECONSTRUCTED

Our system of meanings may serve, in effect, as a universal base for categorially based transformational grammars. There is no need to repeat the phrase-structure rules of categorial well-formedness as a base component in each such grammar. Instead, we take the meanings as given, and regard a grammar as specifying a way to encode meanings: a relation between certain meanings and certain expressions (sequences of sound-types or of mark-types) which we will call the *representing relation* determined by the grammar. We might just identify grammars with representing relations; but I prefer to take grammars as systems which determine representing relations in a certain way.

If we were concerned with nothing but transformation-free categorial grammars, we could take a grammar to consist of nothing but a *lexicon*: a finite set of triples of the form $\langle e\ c\ \phi \rangle$ where e is an expression, c is a category, and ϕ is an intension appropriate for that category. We may say that an expression e *represents* or *has* a meaning m *relative to* a lexicon **L** iff **L** contains items $\langle e_1\ c_1\ \phi_1 \rangle$, ..., $\langle e_n\ c_n\ \phi_n \rangle$ such that, first, e is the result of concatenating e_1, ..., e_n (in that order), and second, the terminal nodes of m are occupied by $\langle c_1\ \phi_1 \rangle$, ..., $\langle c_n\ \phi_n \rangle$ (in that order).

We could instead have proceeded in two steps. Let us define a (*categorial*) *phrase marker* as a tree having categories at its non-terminal nodes and expressions at its terminal nodes. Then a phrase marker p represents or *has* a meaning m *relative to* a lexicon **L** iff p is obtained from m as follows: given any terminal node of the meaning m occupied by a pair $\langle c\ \phi \rangle$, place below it another node occupied by an expression e such that the item $\langle e\ c\ \phi \rangle$ is contained in the lexicon; then remove the intensions, replacing the $\langle c\ \phi \rangle$ pair at each non-terminal node by its unaccompanied category c. Note that the set of meanings thus representable relative to a lexicon **L** comprises all and only those meanings that are generated by

the set of simple meanings of the lexical items themselves; let us call it the set of meanings *generated by* the lexicon **L**.

Next, we define the *terminal string* of a phrase marker p as the expression obtained by concatenating, in order, the expressions at the terminal nodes of p. Thus we see that an expression e represents a meaning m relative to a lexicon **L**, according to the definition above, iff e is the terminal string of some phrase marker that represents m relative to **L**.

In the case of a categorially based transformational grammar, we have not two steps but three. Such a grammar consists of a lexicon **L** together with a *transformational component* **T**. The latter imposes finitely many constraints on finite sequences of phrase markers. A sequence $\langle p_1 \ldots p_n \rangle$ of phrase markers that satisfies the constraints imposed by **T** will be called a (*transformational*) *derivation of* p_n *from* p_1 *in* **T**. An expression e *represents* or *has* a meaning m in a grammar $\langle \mathbf{L}\ \mathbf{T} \rangle$ iff there exists a derivation $\langle p_1 \ldots p_n \rangle$ in **T** such that e is the terminal string of p_n and p_1 represents m relative to the lexicon **L**. If so, we will also call e a *meaningful expression*, p_n a *surface structure of* e, p_{n-1} and ... and p_2 *intermediate structures of* e, p_1 a *base structure of* e, and m a *meaning of* e (all *relative to* the grammar $\langle \mathbf{L}\ \mathbf{T} \rangle$). However, we will call any phrase marker p a *base structure* in $\langle \mathbf{L}\ \mathbf{T} \rangle$ iff it represents a meaning relative to **L**, whether or not it is the base structure *of* any expression; thus we allow for base structures which are filtered out by not being the first term of any derivation in **T**.

The representing relation given by a grammar $\langle \mathbf{L}\ \mathbf{T} \rangle$ is by no means a one-to-one correspondence between meanings and expressions. A given expression might be *ambiguous*, representing several different meanings. (If it represents several different but cointensive meanings, however, it might be inappropriate to call it ambiguous; for the common notion of meaning seems to hover between our technical notions of meaning and of intension.) On the other hand, several expressions might be *synonymous*, representing a single meaning. We might also call several expressions *completely synonymous* iff they share all their meanings; synonymy and complete synonymy coincide when we are dealing only with unambiguous expressions. If several expressions represent different but cointensive meanings, we may call them equivalent but not synonymous. If several expressions not only represent the same meaning but also have a single base structure, we may call them not only equivalent and synonymous but also *paraphrases* of one another.

Given a representing relation, all the semantic relations defined hitherto for meanings carry over to expressions having those meanings. (If we like, they may carry over also to the base, surface, and intermediate structures between the meanings and the expressions.) Thus we know what it means to speak, relative to a given grammar and qualified in cases of ambiguity by 'on a meaning' or 'on all meanings', of the category and intension of any meaningful expression; of the extension at a given index of any expression of appropriate category; of the thing named by a name; of the things to which a common noun applies; of the truth at an index, truth on an occasion, analyticity, logical truth, etc. of a sentence; and so on.

We should note an oddity in our treatment of logical truth. A synonym of a logically true sentence is itself a logical truth, since it represents the same logically true meaning as the original. Hence a descendant by synonym-substitution of a logical truth is itself a logical truth if the synonym-substitution is confined to single lexical items in the base structure; but not otherwise. 'All woodchucks are groundhogs' comes out logically true, whereas 'All squares are equilateral rectangles' comes out merely analytic (in the strongest sense).

A transformational component may constrain sequences of phrase markers in two ways. There is the local constraint that any two adjacent phrase markers in a derivation must stand in one of finitely many relations; these permitted relations between adjacent phrase markers are the *transformations*. There may also be global derivational constraints specifying relations between non-adjacent phrase markers or properties of the derivation as a whole. An example is the constraint requiring transformations to apply in some specified cyclic (or partly cyclic) order.

A transformation-free categorial grammar is a special case of a categorially based transformational grammar. It has a transformational component with no transformations or global constraints, so that the derivations therein are all and only those sequences $\langle p_1 \rangle$ consisting of a single phrase marker.

I will not attempt to say more exactly what a transformation or a transformational component is. Mathematically precise definitions have been given (for instance in Peters and Ritchie, 1969), but to choose among these would involve taking sides on disputed questions in syntactic theory. I prefer to maintain my neutrality, and I have no present need

for a precise delineation of the class of transformational grammars. I have foremost in mind a sort of simplified *Aspects*-model grammar (Chomsky, 1965), but I have said nothing to eliminate various alternatives.

I have said nothing to eliminate generative semantics. What I have chosen to call the 'lexicon' is the *initial* lexicon. Words not in that lexicon might be introduced transformationally on the way from base to surface, if that seems desirable. It might even be that none of the initial lexical items ever reach the surface, and that all surface lexical items (expressions found at terminal nodes of surface structures) are introduced transformationally within derivations. In that case it would be appropriate to use a standardized initial lexicon in all grammars, and to rechristen my base structures 'semantic representations'. In that case also there might or might not be a level between base and surface at which word-introducing transformations are done and other transformations have not yet begun.

I have also said nothing to eliminate surface semantics. This may seem strange, since I have indeed said that meanings are to be determined by base structures alone. However, I rely here on the observation (Lakoff, 1970, § 3) that surface-structure interpretation rules are indistinguishable from global derivational constraints relating three levels: base structures (regarded as semantic representations), deep structures (an *intermediate* level), and surface structures. Deep structures might be ambiguous; a transformational grammar with base-deep-surface constraints might permit two derivations

$$\langle p_{\mathrm{B}}^{1} \cdots p_{\mathrm{D}} \cdots p_{\mathrm{S}}^{1} \rangle$$
$$\langle p_{\mathrm{B}}^{2} \cdots p_{\mathrm{D}} \cdots p_{\mathrm{S}}^{2} \rangle$$

differing at the base and surface but not at the deep level, but it might rule out other derivations of the forms

$$\langle p_{\mathrm{B}}^{2} \cdots p_{\mathrm{D}} \cdots p_{\mathrm{S}}^{1} \rangle$$
$$\langle p_{\mathrm{B}}^{1} \cdots p_{\mathrm{D}} \cdots p_{\mathrm{S}}^{2} \rangle.$$

In such a case base structure (and hence meaning) would be determined by deep and surface structure together, but not by deep structure alone. Similarly, we might have constraints relating base structure not only to deep and surface structure but also to structure at various other intermediate levels.

I have said nothing to eliminate a non-trivial phonological component;

but I would relocate it as part of the transformational component. The last few steps of a transformational derivation might go from the usual pre-phonological surface structure to a post-phonological surface structure whence the output expression can be obtained simply by concatenation of terminal nodes.

I have said nothing to eliminate an elaborate system of selection restrictions; but these will appear not as restrictions on the lexical insertions between meanings and base structures but as transformational filtering later on. There will be base structures representing the meanings of such questionable sentences as 'Seventeen eats beans' and 'He sang a pregnant toothbrush'. But these base structures need not be the first terms of any derivations, so these meanings may be unrepresented by sentences. If we like selection restrictions, we might match the lexicon to the transformational component in such a way as to filter out just those meanings that have the null intension.

I have not stipulated that only sentential meanings may be represented; that stipulation could be added if there is reason for it.

In fact, the *only* restriction I place on syntax is that transformational grammars should be categorially based. In other words: a transformational component should operate on a set of categorial phrase markers representing a set of meanings generated by some lexicon. But categorial bases are varied enough that this restriction is not at all severe. I claim that whatever familiar sort of base component you may favor on syntactic grounds, you can find a categorial base (i.e. a suitable part of the system of meanings, generated by a suitable chosen lexicon) that resembles the base you favor closely enough to share its attractive properties. Indeed, with a few preliminary rearranging transformations you can go from my categorial base structures to (notational variants of) more familiar base structures; then you can proceed exactly as before. I shall not marshall evidence for this claim; but I think that the following exploration of alternative categorial treatments of quantification will exhibit the close similarities between these categorial treatments and several alternative familiar base components. If it were necessary to choose between a categorial base that was convenient for semantics and a non-categorial base that was convenient for transformational syntax, I might still choose the former. But I deny the need to choose.

This completes the exposition of my proposed system of categories,

intensions, and meanings. Now I shall consider how this system – either as is or slightly revised – might be applied to two difficult areas: the semantics of quantification and the semantics of non-declaratives. The treatments following are intended only as illustrations, however; many further alternatives are possible, and might be more convenient for syntax.

VII. TREATMENT OF QUANTIFICATION AND NOUN PHRASES

Let us consider such expressions as 'a pig', 'most pigs', 'seventeen pigs', 'roughly seventeen pigs', 'some yellow pig', 'everything', 'nobody', and the like. We call these *quantifier phrases* (presupposing that they should belong to a common category). What category in our system is this? What sort of intensions do quantifier phrases have?

Quantifier phrases combine with verb phrases to make sentences: 'Some pig grunts', 'Nobody grunts', 'Roughly seventeen pigs grunt', and the like. Names do this, since the category *verb phrase* is the derived category S/N. But quantifier phrases cannot be names, under our semantic treatment of names, because they do not in general name anything. ('The pig' could be an exception at indices such that exactly one pig existed at the world and time given by the index.) The absurd consequences of treating 'nobody', as a name, for instance, are well known (Dodgson, 1871). If a quantifier phrase combines with an S/N to make an S, and yet is not an N, it must therefore be an S/(S/N).

Except perhaps for one-word quantifier phrases – 'nobody', 'everything', and such – quantifier phrases contain constituent common nouns. These may be either simple, as in 'some pig' or compound, as in 'every pink pig that wins a blue ribbon'. Indeed, we may regard common nouns simply as predicates used to restrict quantifiers. (This suggestion derives from Montague, 1970a.) The expressions 'a', 'the', 'some', 'every', 'no', 'most', 'seventeen', 'roughly seventeen', and so on which combine with common nouns (simple or compound) to make quantifier phrases and which are variously called *quantifiers*, *determiners*, or *articles* must therefore belong to the category (S/(S/N))/C. And modifiers of quantifiers like 'roughly' which combine with certain quantifiers to make quantifiers, must belong to the category ((S/(S/N))/C)/((S/(S/N))/C). Selection restrictions by means of transformational filtering could be used to dispose of quantifiers like 'roughly the'.

The intension of 'some pig' may be taken as that function ϕ from S/N-intensions to S-intensions such that if ϕ_1 is any S/N-intension, ϕ_2 is the S-intension $\phi(\phi_1)$, and i is any index, then

$$\phi_2(i) = \begin{cases} \textit{truth} \text{ if, for some N-intension } \phi_3,\ \phi_3(i) \text{ is a pig and} \\ \quad \text{if } \phi_4 \text{ is } \phi_1(\phi_3) \text{ then } \phi_4(i) \text{ is } \textit{truth} \\ \textit{falsity} \text{ otherwise.} \end{cases}$$

The intension of 'some' may be taken as that function ϕ from C-intensions to S/(S/N)-intensions such that if ϕ_1 is any C-intension, ϕ_2 is the S/(S/N)-intension $\phi(\phi_1)$, ϕ_3 is any S/N-intension, ϕ_4 is the S-intension $\phi_2(\phi_3)$, and i is any index, then

$$\phi_4(i) = \begin{cases} \textit{truth} \text{ if, for some N-intension } \phi_5,\ \phi_5(i) \text{ is a member} \\ \quad \text{of } \phi_1(i) \text{ and if } \phi_6 \text{ is } \phi_3(\phi_5) \text{ then } \phi_6(i) \text{ is } \textit{truth} \\ \textit{falsity} \text{ otherwise.} \end{cases}$$

I spare you the intension of 'roughly'.

Other intensions might be specified for 'some pig' and 'some' that would differ from these only when a quantifier phrase was applied to a non-extensional verb phrase. If there are no non-extensional verb phrases in English, then the choice among these alternatives is arbitrary.

This treatment of quantifier phrases is motivated by a desire to handle simple sentences involving quantifier phrases as straightforwardly as possible, minimizing the use of transformations. But it raises problems. Quantifier phrases seemingly occur not only as subjects of sentences but also as objects of verbs or prepositions. And in all their roles – as subjects or as objects – they are interchangeable with names. That is why it is usual to have a category *noun phrase* comprising both quantifier phrases and names.

We might try the heroic course of doubling all our object-takers. We could have one word 'loves' which is an (S/N)/N and takes the object 'Petunia' to make the verb phrase 'loves Petunia'; and alongside it another 'loves' which is an (S/N)/(S/(S/N)) and takes the object 'some pig' to make the verb phrase 'loves some pig'. But we need not decide how much we mind such extravagant doubling, since it does not work anyway. It would give us one meaning for 'Every boy loves some girl': the weaker meaning, on which the sentence can be true even if each boy loves a different girl. But the sentence is ambiguous; where shall we get

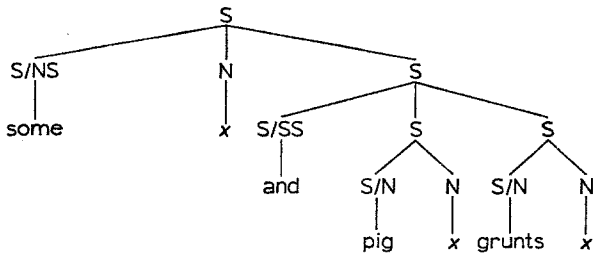
a stronger meaning, on which the sentence is true only if a certain girl – Zuleika, perhaps – is loved by all boys? (There are those who do not perceive this ambiguity; but we seek a treatment general enough to handle the idiolects of those who do.) The method of doubling object-takers is a blind alley; rather we must look to the method of variable binding, routinely used in the semantic analysis of standardly formulated symbolic logic.

The quantifiers of symbolic logic belong to the category S/NS, taking a name and a sentence to make a sentence. The name must be a variable; other combinations could be disposed of by transformational filtering. For instance, the logician's quantifier 'some' takes the variable 'x' and the sentence 'grunts x' to make a sentence translatable into English as 'something grunts'. The logician's 'some' has as its intension that function ϕ from N-intensions and S-intensions to S-intensions such that if ϕ_1 is the nth variable intension for any number n, ϕ_2 is any S-intension, ϕ_3 is $\phi(\phi_1\phi_2)$, and i is any index, then

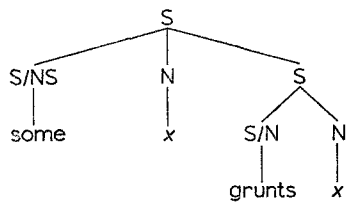
$$\phi_3(i) = \begin{cases} \textit{truth} \text{ if, for some index } i' \text{ that is like } i \text{ except perhaps} \\ \quad \text{at the } n\text{th term of the assignment coordinate,} \\ \quad \phi_2(i') \text{ is } \textit{truth} \\ \textit{falsity} \text{ otherwise;} \end{cases}$$

and such that if ϕ_1 is any N-intension that is not a variable intension and ϕ_2 is any S-intension, then $\phi(\phi_1\phi_2)$ is the null intension. The intension of the logician's quantifier 'every' is specified similarly, with 'for every index i'...' replacing 'for some index i'...'.

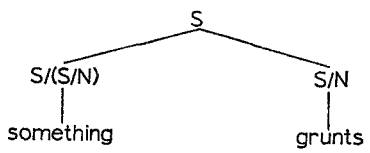
It would be troublesome to employ logician's quantifiers in a grammar for English. In the first place, these quantifiers are unrestricted, ranging over everything. The base structure of 'Some pig grunts', for instance, would come out as



in which there is no constituent corresponding to 'some pig' and in which 'pig' and 'grunts' alike are put into the category S/N. (It was with structures like this in mind that Ajdukiewicz saw fit to omit the category C.) This attempt to dispense with quantifier phrases in favor of unrestricted quantifiers taking compound sentences is clumsy at best, and fails entirely for quantifiers such as 'most' (see Wallace, 1965). In the second place, by having the quantifier itself do the binding of variables, we require there to be bound variables wherever there are quantifiers. We get the unnecessarily complicated base structure



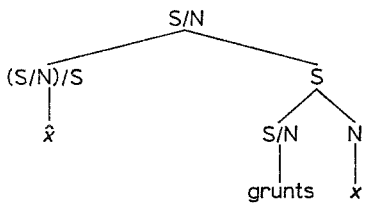
for 'Something grunts', whereas if we had employed quantifier phrases which take verb phrases and do not bind variables, we could have had



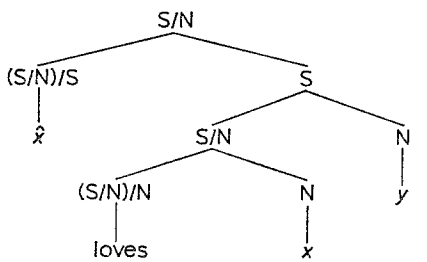
with three constituents instead of six and no work for the transformations to do.

It is not necessary, however, that the quantifier itself should bind variables. We can stick with verb-phrase-taking quantifier phrases of the category S/(S/N), restricted by constituent common nouns in most cases, and bind variables when necessary – but *only* when necessary – by means of a separate constituent called a *binder*: a certain sort of (S/N)/S that takes a sentence and makes an extensional verb phrase by binding a variable at all its free occurrences (if any) in the sentence. To every variable there corresponds a binder. Suppose 'x' is a variable; we may write its corresponding binder as '$\hat{x}$' and read it as 'is something x such that'. (But presumably binders may best be treated as base constituents that never reach the surface; so if the words 'is something x such that'

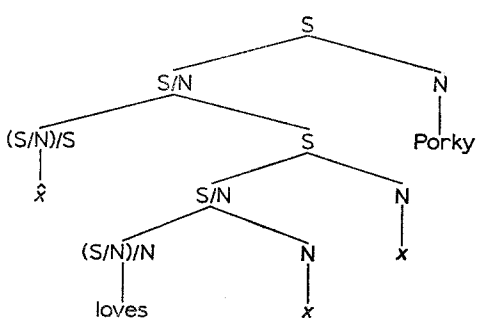
ever appear in a meaningful expression, they will be derived not from an '$\hat{x}$' in base structure but in some other way.) For instance, the following base structure using a binder is equivalent to 'grunts' and might be read loosely as 'is something x such that x grunts'.



The following is a possible base structure for 'is loved by y'.

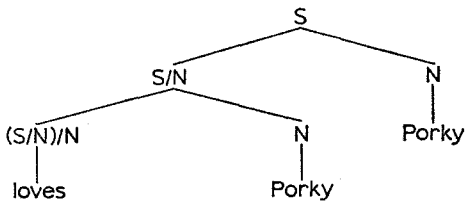


The following might be a base structure for 'Porky loves himself'. (Cf. McCawley, 1969.)



(Provided there is no ambiguity among our variables, we can use them in this way to keep track of coreferentiality, rather than subscripting the

names in



to indicate whether we are dealing with one Porky or two.)

If 'x' has the nth variable intension, then the corresponding binder '$\hat{x}$' has the nth *binder intension*: that function ϕ from S-intensions to S/N-intensions such that if ϕ_1 is any S-intension, ϕ_2 is the S/N-intension $\phi(\phi_1)$, ϕ_3 is any N-intension, ϕ_4 is the S-intension $\phi_2(\phi_3)$, i is any index, and i' is that index which has $\phi_3(i)$ as the nth term of its assignment coordinate and otherwise is like i, then $\phi_4(i) = \phi_1(i')$. It can be verified that this intension justifies the reading of '$\hat{x}$' as 'is something x such that'.

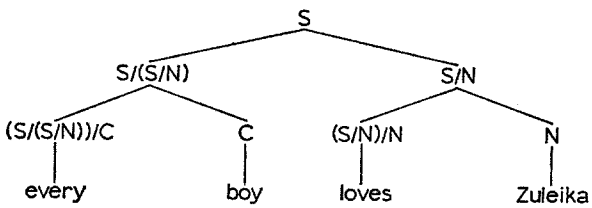
A finite supply of variables and binders, however large, would lead to the mistaken omission of some sentences. To provide an infinite supply by means of a finite lexicon, we must allow our variables and binders to be generated as compounds. We need only three lexical items: one simple variable having the first variable intension; an N/N having as intension a function whose value, given as argument the nth variable intension for any $n \geqslant 1$, is the $(n+1)$th variable intension; and an ((S/N)/S)/N having as intension a function whose value, given as argument the nth variable intension for any $n \geqslant 1$, is the nth binder intension. The first item gives us a starting variable; the second, iterated, manufactures the other variables; the third manufactures binders out of variables. However, we will continue to abbreviate base structures by writing variables and binders as if they were simple.

Variable-binding introduces a sort of spurious ambiguity called *alphabetic variance*. 'Porky loves himself' could have not only the structure shown but also others in which 'x' and '$\hat{x}$' are replaced by 'y' and '$\hat{y}$', or 'z' and '$\hat{z}$', etc. Since different variables may have different intensions, these structures correspond to infinitely many different but cointensive meanings for 'Porky loves himself'. The simplest way to deal with this nuisance is to define an ordering of any such set of meanings and employ

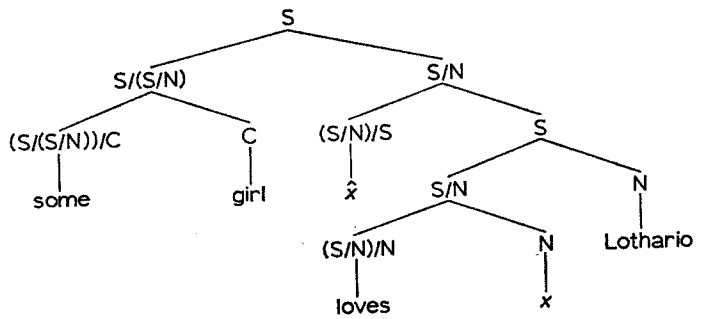
transformational filtering to dispose of all but the first meaning in the set (according to the ordering).

Binders have occasionally been discussed by logicians, under the name 'abstraction operators' or 'lambda operators'. (Church, 1941; Carnap, 1958, § 33; Thomason and Stalnaker, 1968.)

Now we are in a position to complete our account of the category S/(S/N) of verb-phrase-taking quantifier phrases, using binders as needed. The base structure for 'Every boy loves Zuleika' may be simply

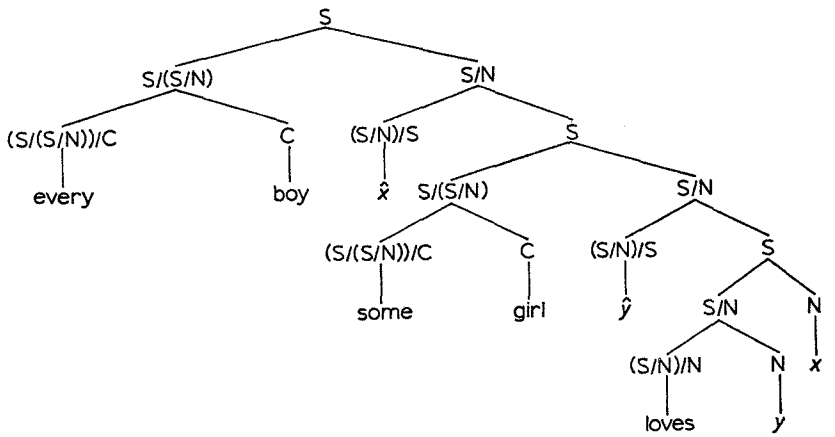


with no unnecessary variable-binding to make work for the transformational component. There is another base structure with variable-binding which we may read roughly as 'Every boy is something x such that x loves Zuleika'; it represents a different but equivalent meaning. We can either let these be another base structure and another (but equivalent) meaning for 'Every boy loves Zuleika' or get rid of them by transformational filtering. The base structure for 'Lothario loves some girl' is

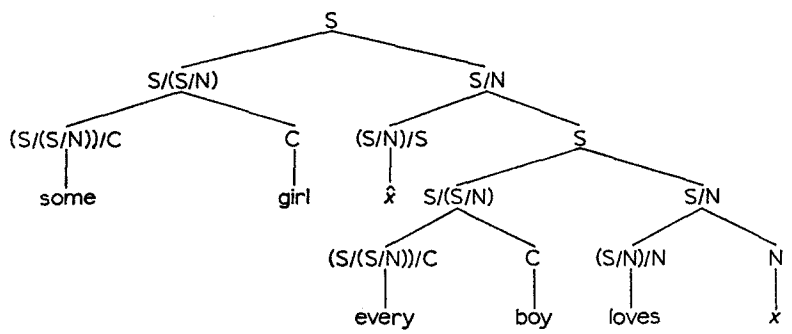


in which the quantifier phrase which is the surface object of 'loves' is treated as subject of a verb phrase obtained by binding the variable which is the base object of 'loves'. To reach an intermediate structure

in which the quantifier phrase is relocated as the object of 'loves', we must have recourse to a transformation that moves the subject of a verb phrase made by variable binding into the place of one (the first?) occurrence of the bound variable and destroys the variable-binding apparatus. Note that, if desired, this transformation might apply *beneath* an intermediate level corresponding most closely to the ordinary level of deep structure. The two base structures for 'Every boy loves some girl' are

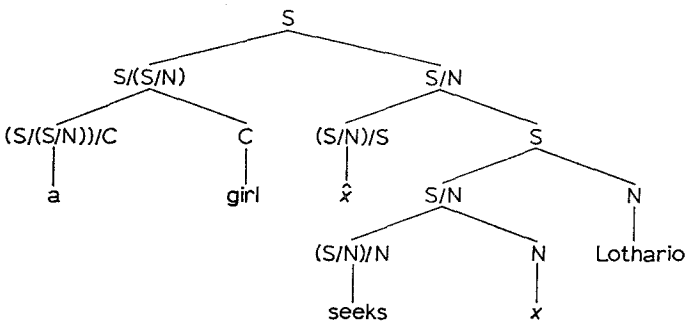


for the weak sense, and

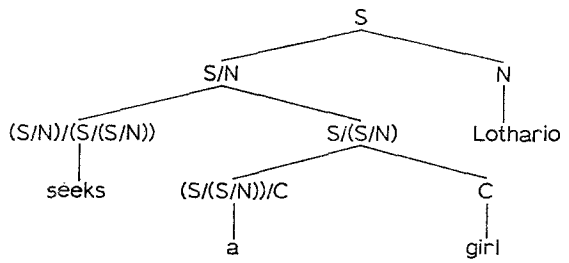


for the strong – Zuleika – sense.

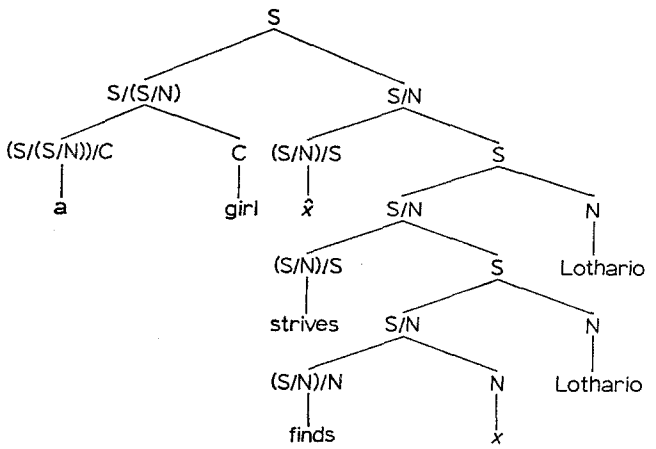
It may be that quantifier-phrase objects should not be abandoned altogether. 'Lothario seeks a girl', in the sense in which it can be paraphrased as 'Lothario seeks a certain particular girl', can have the base structure



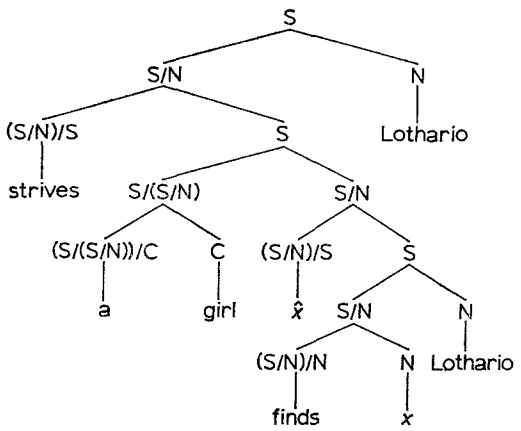
but what about the sense in which any old girl would do? We might give it the base structure



using a second 'seeks' that takes quantifier-phrase objects. The alternative is to let the word 'seeks' be introduced transformationally rather than lexically, as a transformational descendant of 'strives-to-find', so that the base structures would be



for the sense in which a certain particular girl is sought and



for the sense in which any old girl would do. But it is controversial whether we ought to let words be introduced transformationally in this way; and (as remarked in Montague ,1969) it is not clear how to apply this treatment to 'conceives of a tree'. Perhaps conceiving-of is imagining-to-exist, but perhaps not.

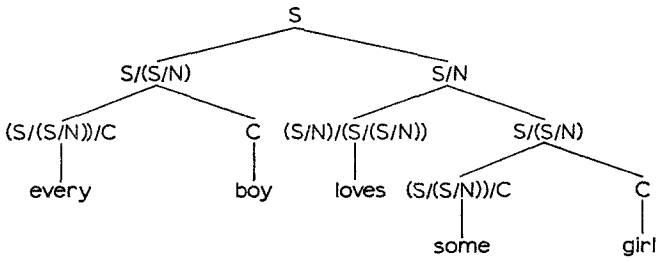
This completes one treatment of quantifier phrases, carried out with no modification of the system I originally presented. It is straightforward from the semantic point of view; however, it might result in excessive complications to transformational syntax. Ordinary bases have a category *noun phrase* which combines quantifier phrases and names; and transformations seem to work well on bases of that sort. By dividing the category of noun phrases, I may require some transformations to be doubled (or quadrupled, etc.). Moreover, my structures involving variable-binding are complicated and remote from the surface, so by doing away with quantifier-phrase objects I make lots of work for the transformational component. It might be, therefore, that this treatment is too costly to syntax. Therefore let us see how we might reinstate the combined category *noun phrase*. There are two methods: we might try to assimilate names to quantifier phrases, or we might try to assimilate quantifier phrases to names.

The method of assimilating names to quantifier phrases proceeds as

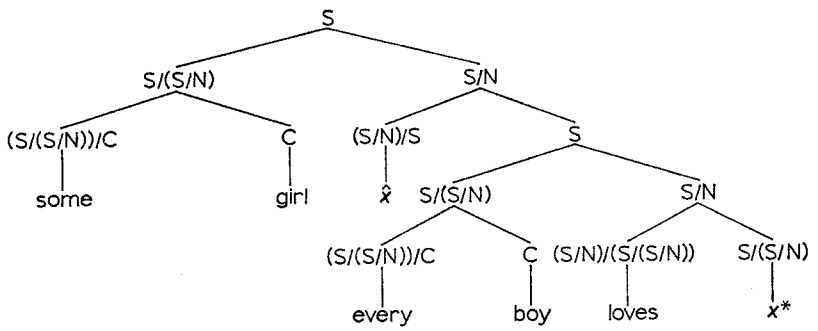
follows. For every name in our lexicon, for instance 'Porky', we add to our lexicon a corresponding *pseudo-name* in the category S/(S/N). If the intension of the original name 'Porky' is the N-intension ϕ_1, then the intension of the corresponding pseudo-name 'Porky*' should be that function ϕ from S/N-intensions to S-intensions such that for any S/N-intension ϕ_2, $\phi(\phi_2) = \phi_2(\phi_1)$. As a result, a sentence such as 'Porky grunts' can be given either of the base structures

and will have the same intension either way. The category S/(S/N) may now be renamed *noun phrase*. It contains our former quantifier phrases together with our new pseudo-names. It does not contain names themselves. Names are now unnecessary as subjects, but still needed as objects; so the next step is to replace all name-takers except verb phrases by noun-phrase-takers. For instance, the category (S/N)/N of transitive verbs is to be replaced by the category (S/N)/(S/(S/N)) of pseudo-transitive verbs. The intensions of the replacements are related to the intensions of the originals in a systematic way which I shall not bother to specify. Names now serve no further purpose, having been supplanted both as subjects and as objects by pseudo-names; so the next step is to remove names from the lexicon. The category N is left vacant.

Since we have provided for noun-phrase objects for the sake of the pseudo-names, we can also have quantifier-phrase objects and so cut down on variable-binding. For instance, we have



as the base structure for 'Every boy loves some girl' in the weak sense, leaving no work for the transformations. We cannot do away with variable-binding altogether, however. The base structure for 'Every boy loves some girl' in the strong – Zuleika – sense is now



in which the seeming noun-phrase object 'some girl' is treated as subject of a verb phrase obtained by binding the pseudo-variable noun phrase 'x^*' which is the real object of 'loves'. Variables are names, of course, and therefore are replaced by pseudo-names just as any other names are; no change is made, however, in the corresponding binders.

So far we have not departed from the system I presented originally, and we *could* stop here. It is now advantageous, however, to take the step of eliminating the category N altogether and promoting the category *verb phrase* from a derived category S/N to a new basic category VP. Accordingly, the category of noun phrases becomes S/VP; the category of quantifiers becomes (S/VP)/C; the category of transitive verbs becomes VP/(S/VP); and the category which includes binders becomes VP/S.

We can also reopen the question of letting verb-phrase intensions be Carnapian rather than compositional. We rejected this simplification before, principally because it would require a projection rule which was not of our general function-and-arguments form; but that consideration no longer holds after names and verb-phrase-plus-name combinations are done away with. A lesser objection still applies: the simplification only works for extensional verb phrases. If any non-extensional verb phrases exist, they cannot go into our new basic category VP with Carnapian intensions. They will have to go into the category S/(S/VP)

instead. The switch to Carnapian intensions for the now-basic verb phrases changes most other intensions in a systematic way which I need not stop to specify.

We turn last to the opposite method, in which quantifier phrases are assimilated to names to give an undivided category of noun phrases. This will require revising the extensions and intensions of names in a manner discussed by Mates (Mates, 1968) and Montague (Montague, 1969 and 1970b).

In the dark ages of logic, a story something like this was told. The phrase 'some pig' names a strange thing we may call the *existentially generic pig* which has just those properties that some pig has. Since some pig is male, some pig (a different one) is female, some pig is pink (all over), and some pig is grey (all over), the existentially generic pig is simultaneously male, female, pink, and grey. Accordingly, he (she?) is in the extensions both of 'is male' and of 'is female', both of 'is pink all over' and of 'is grey all over'. The phrase 'every pig' names a different strange thing called the *universally generic pig* which has just those properties that every pig has. Since not every pig is pink, grey, or any other color, the universally generic pig is not of any color. (Yet neither is he colorless, since not every – indeed not any – pig is colorless). Nor is he(?) male or female (or neuter), since not every pig is any one of these. He is, however, a pig and an animal, and he grunts; for every pig is a pig and an animal, and grunts. There are also the *negative universally generic pig* which has just those properties that no pig has (he is not a pig, but he is both a stone and a number), the *majority generic pig* which has just those properties that more than half of all pigs have, and many more. A sentence formed from a name and an extensional verb phrase is true (we may add: at an index i) if and only if the thing named by the name (at i) belongs to the extension of the verb phrase (at i); and this is so regardless of whether the name happens to be a name like 'Porky' of an ordinary thing or a name like 'some pig' of a generic thing.

This story is preposterous since nothing, however recondite, can possibly have more or less than one of a set of incompatible and jointly exhaustive properties. At least, nothing can have more or less than one of them *as its properties*. But something, a set, can have *any* combination of them *as its members*; there is no contradiction in that.

Let us define the *character* of a thing as the set of its properties. Porky's

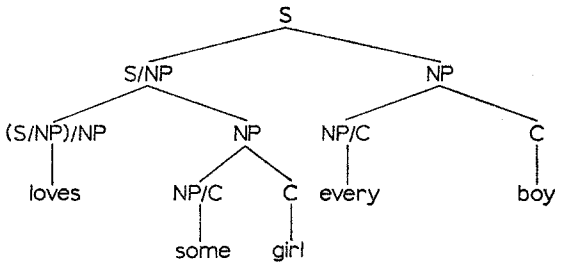
character is that set which has as members just those properties that Porky has as properties. The various generic pigs do not, and could not possibly, exist; but their characters do. The character of the universally generic pig, for instance, is the set having as members just those properties that every pig has as properties.

A *character* is any set of properties. A character is *individual* iff it is a maximal compatible set of properties, so that something could possess all and only the properties contained in it; otherwise the character is *generic*.

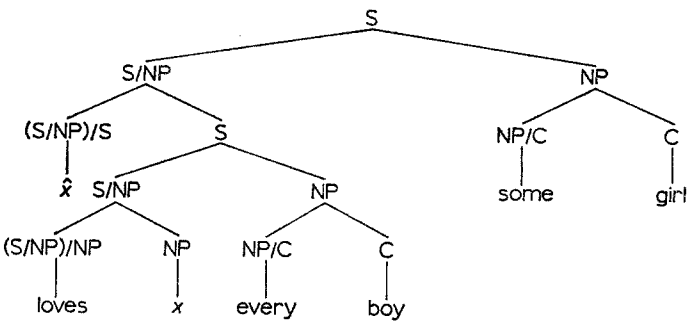
Since no two things share all their properties (on a sufficiently inclusive conception of properties) things correspond one-to-one to their individual characters. We can exploit this correspondence to replace things by their characters whenever convenient. Some philosophers have even tried to eliminate things altogether in favor of their characters, saying that things are 'bundles of properties'. (Such a system is proposed as a formal reconstruction of Leibniz's doctrine of possible individuals in Mates, 1968.) We need not go so far. We will replace things by individual characters as extensions of names, and as members of extensions of common nouns. However, we may keep the things themselves as well, taking them to be related to their names via their characters. Having made this substitution, we are ready to assimilate quantifier phrases to names by letting them also take characters – in most cases, generic characters – as extensions. 'Porky' has as extension Porky's individual character; 'every pig' has as extension the generic character of the universally generic pig. Even 'nobody' has an extension: the set of just those properties that nobody has.

We revise the system of meanings as follows. Our basic categories are *sentence* (S), *noun phrase* (NP), and *common noun* (C). Appropriate extensions for sentences are truth values; appropriate extensions for noun phrases are characters, either individual or generic; appropriate extensions for common nouns are sets of individual characters. Intensions are as before: for basic categories, functions from some or all indices to appropriate extensions; for a derived category $(c/c_1 \ldots c_n)$, functions from c_1-intensions, ..., and c_n-intensions to c-intensions. A *name* is an NP that never has a generic character as its extension at any index. The category of quantifiers becomes NP/C; the category of verb phrases becomes S/NP. Object-takers take NP objects which may or may not be names. Some variable-binding still is required; the two base structures for 'Every boy

loves some girl' are



for the weak sense and



for the strong sense. Variables are names: the *n*th variable intension now becomes that NP-intension that assigns to every index *i* the character at the world coordinate of *i* of the thing that is the *n*th term of the assignment coordinate of *i*. The intensions of binders are revised to fit.

VIII. TREATMENT OF NON-DECLARATIVES

A meaning for a sentence, we said initially, was at least that which determines the conditions under which the sentence is true or false. But it is only declarative sentences that can be called true or false in any straightforward way. What of non-declarative sentences: commands, questions, and so on? If these do not have truth-values, as they are commonly supposed not to, we cannot very well say that their meanings determine their truth conditions.

One method of treating non-declaratives is to analyze all sentences,

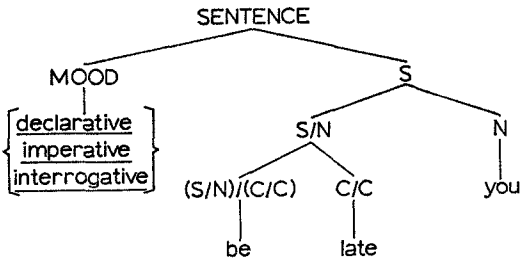
declarative or non-declarative, into two components: a *sentence radical* that specifies a state of affairs and a *mood* that determines whether the speaker is declaring that the state of affairs holds, commanding that it hold, asking whether it holds, or what. (I adopt the terminology of Stenius, 1967, one recent exposition of such a view.) We are to regard the sentences

It is the case that you are late.
Make it the case that you are late!
Is it the case that you are late?

or more idiomatically

You are late.
Be late!
Are you late?

as having a common sentence-radical specifying the state of affairs consisting of your being late, but differing in their moods: declarative, imperative, and interrogative. They might be given the base structures



with S now understood as the category *sentence radical.* Different moods will induce different transformations of the sentence radical, leading to the different sentences above. The sentence radical is *not* a declarative sentence. If it is represented on the surface at all, it should be represented as the clause 'that you are late'. All that we have said about sentences should be taken as applying rather to sentence radicals. It is sentence radicals that have truth-values as extensions, functions from indices to truth-values as intensions, and meanings with the category S and an S-intension at the topmost node. We may grant that a declarative sentence

is called true iff its sentence radical has the value *truth*; if we liked, we could also call an imperative or interrogative or other non-declarative sentence true iff its sentence radical has the value *truth*, but we customarily do not. Fundamentally, however, the entire apparatus of referential semantics (whether done on a categorial base as I propose, or otherwise) pertains to sentence radicals and constituents thereof. The semantics of mood is something entirely different. It consists of rules of language use such as these (adapted from Stenius, 1967):

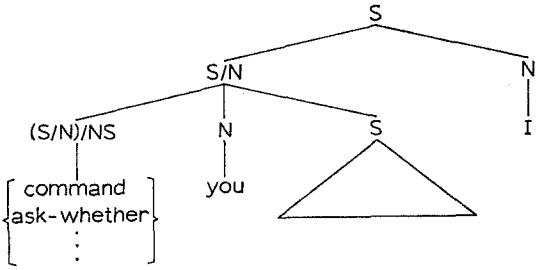
Utter a sentence representing the combination of the mood *declarative* with an S-meaning *m* only if *m* is true on the occasion in question.

React to a sentence representing the combination of the mood *imperative* with an S-meaning *m* (if adressed to you by a person in a suitable relation of authority over you) by acting in such a way as to make *m* true on the occasion in question.

In abstract semantics, as distinct from the theory of language use, a meaning for a sentence should simply be a *pair* of a mood and an S-meaning (moods being identified with some arbitrarily chosen entities).

The method of sentence radicals requires a substantial revision of my system. It works well for declaratives, imperatives, and yes-no questions. It is hard to see how it could be applied to other sorts of questions, or to sentences like 'Hurrah for Porky!'

I prefer an alternative method of treating non-declaratives that requires no revision whatever in my system of categories, intensions, and meanings. Let us once again regard S as the category *sentence*, without discrimination of mood. But let us pay special attention to those sentential meanings that are represented by base structures of roughly the following form.



Such meanings can be represented by *performative sentences* such as these.

I command you to be late.
I ask you whether you are late.

(See Austin, 1962, for the standard account of performatives; but, as will be seen, I reject part of this account.) Such meanings might also be represented, after a more elaborate transformational derivation, by non-declaratives.

Be late!
Are you late?

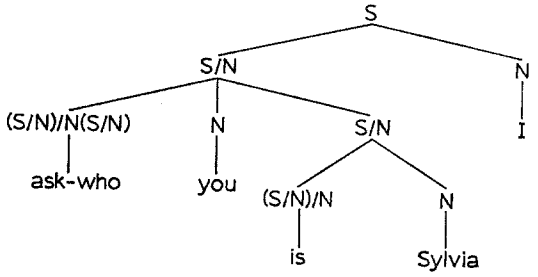
I propose that these non-declaratives ought to be treated as paraphrases of the corresponding performatives, having the same base structure, meaning, intension, and truth-value at an index or on an occasion. And I propose that there is no difference in kind between the meanings of these performatives and non-declaratives and the meanings of the ordinary declarative sentences considered previously.

It is not clear whether we would classify the performative sentences as declarative. If not, then we can divide sentential meanings into declarative sentential meanings and non-declarative sentential meanings, the latter being represented both by performatives and by imperatives, questions, etc. But if, as I would prefer, we classify performatives as declarative, then the distinction between declarative and non-declarative sentences becomes a purely syntactic, surface distinction. The only distinction among meanings is the distinction between those sentential meanings that can only be represented by declarative sentences and those that can be represented either by suitable declarative sentences (performatives) or by non-declarative paraphrases thereof. Let us call the latter *performative sentential meanings*. I need not delineate the class of performative sentential meanings precisely, since I am claiming that they do *not* need to be singled out for special semantic treatment.

The method of paraphrased performatives can easily be extended to those non-declaratives that resisted treatment by the method of sentence radicals. Not only yes-no questions but other questions as well correspond to performative sentences. The sentences below

I ask who Sylvia is.
Who is Sylvia?

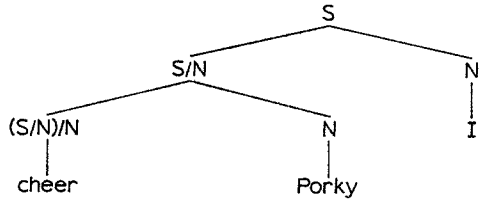
for instance, might have a common meaning represented by a base structure something like this.



And the sentences

I cheer Porky.
Hurrah for Porky!

might have this base structure. (Thus the word 'Hurrah' would be introduced transformationally.)



We may classify the sentential meanings represented by these base structures also as performative.

We noted at the outset that non-declaratives are commonly supposed to lack truth-values. The method of sentence radicals respects this common opinion by assigning truth-values fundamentally to sentence radicals rather than to whole sentences. We are under no compulsion to regard a non-declarative sentence as sharing the truth-value of its sentence radical, and we have chosen not to. The method of paraphrased performatives, on the other hand, does call for the assignment of truth-values to non-declarative sentences. The truth-value assigned is not that of the embedded sentence (corresponding to the sentence radical), however, but rather that of the paraphrased performative. If I say to you 'Be late!' and you are not late, the embedded sentence is false, but the paraphrased

performative is true because I *do* command that you be late. I see no problem in letting non-declaratives have the truth-values of the performatives they paraphrase; after all, we need not ever mention their truth-values if we would rather not.

So far, I have assumed that performatives themselves do have truth-values, but that also has been denied. (Austin, 1962, Lecture I.) I would wish to say that 'I bet you sixpence it will rain tomorrow' is true on an occasion of utterance iff the utterer *does* then bet his audience sixpence that it will rain on the following day; and, if the occasion is normal in certain respects, the utterer does so bet; therefore his utterance is true. Austin says it is obviously neither true nor false, apparently because to utter the sentence (in normal circumstances) is to bet. Granted; but why is that a reason to deny that the utterance is true? To utter 'I am speaking' is to speak, but it is also to speak the truth. This much can be said in Austin's defense: the truth-values (and truth conditions, that is intensions) of performatives and their paraphrases are easily ignored just because it is hard for a performative to be anything but true on an occasion of its utterance. Hard but possible: you can be play-acting, practicing elocution, or impersonating an officer and say 'I command that you be late' falsely, that is, say it without thereby commanding your audience to be late. I claim that those are the very circumstances in which you could falsely say 'Be late!'; otherwise it, like the performative, is truly uttered when and because it is uttered. It is no wonder if the truth-conditions of the sentences embedded in performatives and their non-declarative paraphrases tend to eclipse the truth conditions of the performatives and non-declaratives themselves.

This eclipsing is most visible in the case of performative sentences of the form 'I state that ___' or 'I declare that ___'. If someone says 'I declare that the Earth is flat' (sincerely, not play-acting, etc.) I claim that he has spoken truly: he does indeed so declare. I claim this not only for the sake of my theory but as a point of common sense. Yet one might be tempted to say that he has spoken falsely, because the sentence embedded in his performative – the content of his declaration, the belief he avows – is false. Hence I do not propose to take ordinary declaratives as paraphrased performatives (as proposed in Ross, 1968) because that would get their truth conditions wrong. If there are strong syntactic reasons for adopting Ross's proposal, I would regard it as semantically

a version of the method of sentence radicals, even if it employs base structures that look exactly like the base structures employed in the method of paraphrased performatives.

I provide only one meaning for the sentence 'I command you to be late'. Someone might well object that this sentence ought to come out ambiguous, because it can be used in two ways. It can be used to command; thus used, it can be paraphrased as 'Be late!', and it is true when uttered in normal circumstances just because it is uttered. It can be used instead to describe what I am doing; thus used, it cannot be paraphrased as an imperative, and it is likely to be false when uttered because it is difficult to issue a command and simultaneously say that I am doing so. (Difficult but possible: I might be doing the commanding by signing my name on a letter while describing what I am doing by talking.)

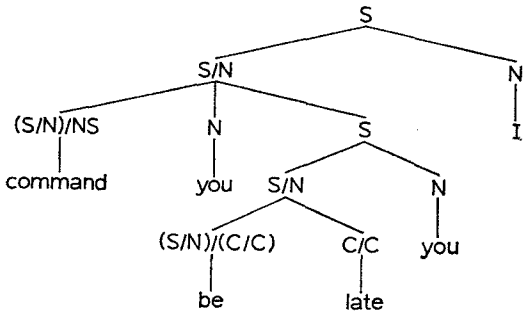
I agree that there are two alternative uses of this and other performative sentences: the genuinely performative use and the non-performative self-descriptive use. I agree also that the non-declarative paraphrase can occur only in the performative use. It still does not follow that there are two meanings. Compare the case of these two sentences.

> I am talking in trochaic hexameter.
> In hexameter trochaic am I talking.

The latter can be used to talk in trochaic hexameter and is true on any occasion of its correctly accented utterance. The former cannot be so used and is false on any occasion of its correctly accented utterance. Yet the two sentences are obviously paraphrases. Whether a sentence can be used to talk in trochaic hexameter is not a matter of its meaning. The distinction between using a sentence to talk in trochaic hexameter or not so using it is one sort of distinction; the distinction between using a performative sentence performatively and using it self-descriptively is quite another sort. Still I think the parallel is instructive. A distinction in uses need not involve a distinction in meanings of the sentences used. It can involve distinction in surface form; or distinction in conversational setting, intentions, and expectations; or distinction of some other sort. I see no decisive reason to insist that there is any distinction in meanings associated with the difference between performative and self-descriptive uses of performative sentences, if the contrary assumption is theoretically convenient.

We may ask to what extent the method of sentence radicals and the method of paraphrased performatives are compatible. In particular: given any sentence that can be analyzed into mood and sentence-radical, can we recover the mood and the sentence-radical intension from the meaning of the sentence according to the method of paraphrased performatives?

We almost can do this, but not quite. On the method of sentence radicals, the difference between the performative and self-descriptive uses of performative sentences *must* be treated as a difference of meanings. So given a performative sentence meaning, we will get two pairs of a mood and a sentence-radical intension corresponding to the two uses. Suppose we are given a performative sentential meaning represented by a base structure like this, for instance.



For the self-descriptive use, we do just what we would do for a non-performative sentence meaning: take the mood to be *declarative* and the sentence-radical intension to be the intension of the entire meaning. In this case, it would be the intension corresponding to the sentence radical 'that I command you to be late'. For the performative use, we take the mood to be determined by the (S/N)/NS-intension at node $\langle 1, 1 \rangle$, and the sentence-radical intension to be the S-intension at node $\langle 1, 3 \rangle$. In this case, these are respectively the intension of 'command', which determines that the mood is *imperative*, and the S-intension of the embedded sentence meaning, corresponding to the sentence radical 'that you are late'. Note here a second advantage, apart from fineness of individuation, of taking meanings as semantically interpreted phrase markers rather than as single intensions: we can recover the meanings of constituents from the meanings of their compounds.

APPENDIX: INDICES EXPANDED

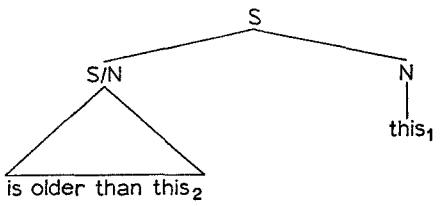
Indices are supposed to be packages of everything but meaning that goes into determining extensions. Do we have everything? Let me speculate on several expansions of the indices that might prove useful.

First, consider the sentence '*This* is older than *this*'. I might say it pointing at a 1962 Volkswagen when I say the first 'this' and at a 1963 Volkswagen when I say the second 'this'. The sentence should be true on such an occasion; but how can it be? Using the intension of 'this', with its sensitivity to the indicated-objects coordinate, we obtain the intension of the whole sentence; then we take the value of that intension at an index with world and contextual coordinates determined by features of the occasion of utterance. (We generalize over indices alike except at the assignment coordinate; but we can consider any one of these, since the assignment coordinate is irrelevant to the sentence in question.) This procedure ignores the fact that the indicated object changes part-way through the occasion of utterance. So the sentence comes out false, as it should on any occasion when the indicated object stays the same.

On a more extensional approach to semantics, a solution would be easy. We could take the two extensions of 'this' on the two occasions of its utterance and use these, rather than the fixed intension of 'this', to determine the truth-value of the sentence. The intension and the occasion of utterance of the sentence as a whole would drop out. But since the extensions of compounds are not in general determined by the extensions of their constituents, this extensional solution would preclude a uniform treatment of semantic projection rules.

An acceptable solution has been suggested to me by David Kaplan, as follows. Let the indicated-objects coordinate be not just one set of objects capable of being pointed at but an infinite sequence of such sets. Let the indicated-objects coordinate determined by a given occasion of utterance of a sentence have as its nth term the set of things pointed to at the nth utterance of 'this' during the utterance of the sentence so long as n does not exceed the number of such utterances, and let it be the empty set when n does exceed that number. Let there be an infinite sequence of constituents 'this_1', 'this_2',... with intensions such that 'this_n' depends for its extension at an index on the nth term of the assignment coordinate. So that the lexicon will remain finite, let all but 'this_1' be

compounds generated by iterated application of a suitable N/N to 'this_1'. Let all members of the sequence appear as 'this' in surface structure. Use transformational filtering to dispose of all base structures except those employing an initial segment of the 'this'-sequence so arranged that if the subscripts were carried to the surface, they would appear in numerical order without repetition. Thus the only base structure for 'This is older than this' will be



which will be true on occasions of the sort in question.

The solution must be modified to allow for the fact that 'this' is not the only demonstrative; I omit details. Similar difficulties arise, and similar solutions are possible, for other contextual coordinates: time, place, audience, and perhaps speaker.

Second, consider the sentence 'The door is open'. This does not mean that the one and only door that now exists is open; nor does it mean that the one and only door near the place of utterance, or pointed at, or mentioned in previous discourse, is open. Rather it means that the one and only door among the objects that are somehow prominent on the occasion is open. An object may be prominent because it is nearby, or pointed at, or mentioned; but none of these is a necessary condition of contextual prominence. So perhaps we need a *prominent-objects coordinate*, a new contextual coordinate independent of the others. It will be determined, on a given occasion of utterance of a sentence, by mental factors such as the speaker's expectations regarding the things he is likely to bring to the attention of his audience.

Third, consider the suggestion (Kaplan, 1968; Donnellan, 1970) that the extension of a personal name on a given occasion depends partly on the causal chain leading from the bestowal of that name on some person to the later use of that name by a speaker on the occasion in question. We might wish to accept this theory, and yet wish to deny that the intension or meaning of the name depends, on the occasion in question,

upon the causal history of the speaker's use of it; for we might not wish to give up the common presumption that the meaning of an expression for a speaker depends only on mental factors within him. We might solve this dilemma (as proposed in Lewis, 1968b) by including a *causal-history-of-acquisition-of-names coordinate* in our indices and letting the intensions of names for a speaker determine their extensions only relative to that coordinate.

Fourth, we have so far been ignoring the vagueness of natural language. Perhaps we are right to ignore it, or rather to deport it from semantics to the theory of language-use. We could say (as I did in Lewis, 1969, Chapter V) that languages themselves are free of vagueness but that the linguistic conventions of a population, or the linguistic habits of a person, select not a point but a fuzzy region in the space of precise languages. However, it might prove better to treat vagueness within semantics, and we could do so as follows. (A related treatment, developed independently, is to be found in Goguen, 1969.)

Pretend first that the only vagueness is the vagueness of 'cool' and 'warm'; and suppose for simplicity that these are extensional adjectives. Let the indices contain a *delineation coordinate*: a positive real number, regarded as the boundary temperature between cool and warm things. Thus at an index i the extension of 'cool' is the set of things at the world and time coordinates of i having temperatures (in degrees Kelvin) less than or equal to the delineation coordinate of i; the extension of 'warm' is the set of such things having temperatures greater than the delineation coordinate. A vague sentence such as 'This is cool' is true, on a given occasion, at some but not all delineations; that is, at some but not all indices that are alike except in delineation and have the world and contextual coordinates determined by the occasion of utterance. But sentences with vague constituents are not necessarily vague: 'This is cool or warm, but not both' is true at all delineations, on an occasion on which there is a unique indicated object, even if the indicated object is lukewarm.

The delineation coordinate is non-contextual. It resembles the assignment coordinate, in that we will ordinarily generalize over it rather than hold it fixed. We may say that a sentence is *true over* a set s of delineations at an index i, iff, for any index i' that is like i except perhaps at the delineation coordinate, the sentence is true at i' if and only if the delineation coordinate of i' belongs to s. Given a normalized measure function

over delineations, we can say that a sentence is *true to degree d* at *i* iff it is true at *i* over a set of delineations of measure *d*. Note that the degree of truth of a truth-functional compound of sentences is not a function of the degrees of truth of its constituent sentences: '*x* is cool' and '*x* is warm' may both be true to degree .5 at an index *i*, but '*x* is cool or *x* is cool' is true at *i* to degree .5 whereas '*x* is cool or *x* is warm' is true at *i* to degree 1.

Treating vagueness within semantics makes for simple specifications of the intensions of such expressions as 'in some sense', 'paradigmatic', '____ish', and '____er than'. The contemporary idiom 'in some sense', for instance, is an S/S related to the delineation coordinate just as the modal operator 'possibly' is related to the world coordinate. The intension of 'in some sense' is that function ϕ such that if ϕ_1 is any S-intension, ϕ_2 is $\phi(\phi_1)$, and *i* is any index, then

$$\phi_2(i) = \begin{cases} \textit{truth} \text{ if, for some index } i' \text{ that is like } i \text{ except perhaps} \\ \quad \text{at the delineation coordinate, } \phi_1(i') \text{ is } \textit{truth} \\ \textit{falsity} \text{ otherwise.} \end{cases}$$

The comparative '____er than' is a ((C/C)/N)/(C/C) having an intension such that, for instance, '*x* is cooler than *y*' is true at an index *i* iff the set of delineations over which '*y* is cool' is true at *i* is a proper subset of the set of delineations over which '*x* is cool' is true at *i*. It follows that the sun is not cooler than Sirius unless in some sense the sun is cool; but that conclusion seems correct, although I do not know whether to deny that the sun is cooler than Sirius or to agree that in some sense the sun is cool. (This analysis of comparatives was suggested to me by David Kaplan.)

More generally, the delineation coordinate must be a sequence of boundary-specifying numbers. Different vague expressions will depend for their extensions (or, if they are not extensional, for the extensions of their extensional compounds) on different terms of the delineation. More than one term of the delineation coordinate might be involved for a single expression. For instance, the intension of 'green' might involve one term regarded as delineating the blue-green boundary and another regarded as delineating the green-yellow boundary. The former but not the latter would be one of the two terms involved in the intension of 'blue'; and so on around the circle of hues.

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